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CONSERVATION OF POTABLE WATER AND THE DUAL SYSTEM OF DISTRIBUTION

By Henry C. Hodgkins

Many members of this Association will recall the first installations of mechanical filters and those of us who undertook the work of installations in the late eighties will recall the spirit of incredulity with which the propositions were received. The whole germ theory of disease was in its infancy and the real science of filtration can be said to have developed coevally with the investigation and classification of bacteria.

It has been our fortune to follow the development of both slow and rapid sand filtration from the first principles to the present high scientific and efficient results.

With all that has been attained, the field is large and much remains to be done and many difficulties to be overcome.

The sanitarians and engineers have accomplished great things and have worked so persistently that every home has caught the slogans: "Swat the Fly," "Squirt the Flea," "Oil the Mosquito," "Coagulate the Bacteria," set the different tribes at warfare, a thousand times more fierce and numerous than the war among the Bulgarians. Put all the survivors to sleep with a little Hypo, and still when we return to our favorite beverage, with a little water on the side, there is perched the eternal germ, blinking away from the drowse to which he was chlorited.

In all seriousness the question of pure water is growing more complicated and difficult every year. In the language of the opening sentences of the lecture of a celebrated Brooklyn divine, "The United States has now 95,000,000 of people and shortly will have 500,000,000 of people." Is it any wonder that the question of food supplies is appalling and that the greatest food supply of all, pure water, should cause water works men to stand aghast at the problems that confront them? Just for a moment let your mind revert to the great rivers of supply carried by such works as supply Los Angeles, the City of New York, and the enormous proposition for the little city of Ottawa. Just try to grasp what all this means and where it is leading us as the country grows toward its 500,000,000 of population. Think of meeting all this flood and carrying on a warfare of bug extermination. And all for what purpose: simply that we may have a little pure water to drink as we enjoy an evening's sociability.

All of the waters of the Great Lakes have been condemned by an international commission. Not a river in all this broad land has escaped the censure of the sanitarian. Conditions are not improving but constantly growing worse. All the disposal plants that are being, or may be constructed will only mitigate the trouble from sewage to the extent of preventing its being branded as a nuisance. The warfare once started, must continue in increasing proportions with recruits coming faster than they can be annihilated.

The totals of water consumption are increasing so enormously that potability for the entire supply is being considered by a large portion of consumers as shrouded in doubt. Is it not time that we should recognize the tremendous size of the problem and proceed to furnish water of unquestioned purity, where pure water is required, through a separate or dual system? The writer advocated the proposition before this Association 16 years ago, and now as then, he hears the murmur that the plan is impracticable, unscientific and contrary to the established principles of hydraulic engineering. On the other hand he hears the call of the thirsty from the time of Hagar crying in the wilderness, down through the ages to the present, when thousands upon thousands are turning from the faucet to the bottle for their water, and the cry is becoming more and more insistent for pure water to drink.

The daily average consumption per capita for cities in this country will run from 100 to as high as 200 gallons. Very few large places will average less than 100 gallons. The maximum per capita consumption will run from two to four times the average. The average daily consumption per capita for domestic purposes will amount to from 25 to 30 per cent of the total average, and the amount required for culinary and drinking purposes will amount to from 3 to 5 per cent of the total. The amount of potable water thus required is very nearly a constant quantity from day to day. According to a paper presented to this Association a year ago there were some 400 water works filtration plants in this country, about the same number as there were water works when the writer started in the business. These filtration plants cost from 12 to 20 per cent of the total cost of the remaining portion of the water works in the case of mechanical filters and 20 to 30 per cent in the case of slow sand filters. In Pittsburgh, the estimated cost was 30 per cent and in Toronto 20 per cent of the previous cost of the works.

In a city of 100,000, Mr. Leonard Metcalf estimates the cost of that portion of a distribution system due to domestic consumption at 22 per cent, that due to industrial consumption at 32 per cent and that due to fire protection at 47 per cent. If the division is carried farther that portion due to culinary and drinking purposes would be about 4 per cent.

If the distribution system could be separated into distinct systems and at the above proportionate costs the problem of dual systems would be easy. But such is not the case. The cost of a dual system in terms for a complete system would vary widely, but as a general proposition it is a fair statement that a separate system to supply the inhabitants of a city with potable water would cost from 25 to 30 per cent of the distribution system as generally constructed. In other words that the cost of the dual system would be from 70 to 150 per cent of the cost of the filtration plant, varying widely according to conditions and according to which system of filtration is used.

There is a wide range in the cost of filtering water. Making due allowance for maintenance of plant, interest and depreciation, the cost would probably fall between 1 cent and 1.5 cent per thousand gallons. Assuming a cost of 1.2 cent per thousand gallons, the cost of filtering

1,000,000 gallons per day would be	$12.00
40,000 gallons per day would be	.48
Difference per day due to filtration	11.52

That is, if instead of filtering all of the water, only the portion furnished through the dual system was filtered, the saving in the cost of filtration would amount to $11.52 per million. From this would have to be deducted the interest, depreciation and maintenance of the dual system which in a medium sized city would require not to exceed half of this saving, leaving the remainder for the additional cost of administration and saving to the department.

The pure water should sell at a much higher rate than the raw water for two reasons: first, to provide ample revenue to cover all charges due to the dual system, including service pipes and meters;

and second, the price should be high enough to prevent the use of pure water for other purposes than those intended.

These figures are merely illustrative but they are sufficient to show that the dual system is not impossible from a cost point of view, but that it is entirely feasible and in many instances the solution of a very difficult situation.

It is not claimed that the dual system should be universally adopted, but in places where there is a supply of naturally pure water sufficient to meet the culinary and drinking requirements it is urged that it be supplied through a separate system, leaving the larger requirements to be furnished from the nearest and cheapest source of reasonably clean water.

There are many instances where towns have outgrown their water supply; the present supply being excellent in quality but insufficient in quantity. Just such an instance exists in the writer's practice. The demands have increased beyond the supply and the capacity of the distribution mains. It has been recommended and considered with favor, that a duplicate system covering nearly half of the town be installed, furnishing a water more suitable for manufacturing purposes but not fit for drinking; the original distribution to supply all of the needs of a portion of the residential section from the original source, with the smaller mains extended to all parts of the town, supplying all the inhabitants with the excellent drinking water; it being the expectation that as the city grows the dual system would be extended until the entire city is covered.

Because the industrial growth of the town has caused a demand beyond the capacity of the supply, but which is still sufficient for all house supplies for even a much larger town, should the best of nature's supplies be discarded and replaced by a filtered supply?

The difficulties of supplying the ever increasing demand with a potable water are such that all naturally pure waters should be conserved, and it would seem that it is time that the scientific planning of dual systems should be commenced. It is not the purpose of this paper to criticize work that has been done or that is under way; but to emphasize a new departure in water works construction and management. There is no reason why the bottled purveyors should have the best of the business. Pure water, like other food products, should be conserved and delivered in the best possible manner.

The great argument against the dual supply has been the difficulty of controlling its use. It has been argued that poor people would use the cheaper water, and that many, especially new arrivals in the city, from ignorance would use the contaminated water. Every precaution should of course be taken to prevent the wrong use of either water. The drinking faucets should be of one handsome ornamental design, properly labeled. All other faucets should be of the same and an entirely different and distinctive design. Greater care and inspection of all fixtures would be necessary, which would certainly be progress in the right direction.

DISCUSSION

Mr. J. M. Diven: It would appear to the speaker that one objection that the author failed to mention is the cost. Would it not be well to investigate and find out whether it would cost more to filter all the water and use all pure water, or to put in a dual system; in other words, would not the interest and depreciation cost on a dual system cost so much as to more than offset the cost of purifying the entire supply? It must also be remembered that with the entire supply purified there would be no danger of people getting the wrong water, which is a danger to be feared from carelessness or ignorance.

Mr. J. N. Chester: To discuss a paper, of course, is not always to agree with it. The speaker is aware now why Mr. Hodgkins was asking him some questions about consumption and why he was insisting that most consumption was over 100 gallons per capita per day. The speaker cannot agree that a dual system is beneficial or advisable from any practical standpoint; it may be advisable in an exceptional case, but certainly not as a rule. It might be a possibility to be considered in one case out of a hundred, but in the other ninety-nine cases it would be found, upon a thorough investigation and comparison of costs, to be impossible. Let us inquire what our water supplies are today; they are either surface waters, which, to be pure or potable, must be purified, or they are naturally filtered or subterranean supplies, which in most cases are much harder and less adapted to domestic uses in many ways than are surface supplies; that is, they are not as practical. Well water in most cases is purely a drinking water. The water for purely domestic purposes is the filtered surface supply in at least nine cases out of ten.

Now, so far as the cost of a dual system is concerned, the previous statements may be qualified a little by saying that the dual system does exist in most places today, but it is not credited as such by the author of this paper. In Pittsburgh there is pumped to the industries of that town raw water from the river to over ten times the amount of the water that is pumped to the city, and that city is using 100,000,000 gallons a day. Thus you can see what our industries are doing along our rivers. Go to any town, and you will find that the industries that can better use the raw water from the streams are located along the streams.

Let us go a little beyond the Alleghenies and see what the turbidity of the rivers is. What do we filter water for? Because our industries demand purification or clarification of the water supplies just the same as the inhabitants who take the water; and if you draw it out of wells the health officers and state engineers will tell you that they are requiring now that the water shall be kept down to less than one-half of one p.p.m. of iron before they will approve its use and where is the well water that produces less iron than that in its natural state? One of the previous speakers (Mr. Diven), has touched clearly on a vital point in this matter, and that is the cost. Again, the best work of purification is not done by our small plants. Suppose that only the small portion of water that is to be drunk is filtered, are you going to get results from a small filter plant equal to those of a filter of larger capacity? No. And that is one case where wholesale is better than retail as to quality. Mr. John W. Hill, of Cincinnati, years ago brought up the question of distilling all the water, but certainly that would not be practicable, and the speaker has seen very few cases where it could apply. If you had a spring that was thoroughly protected and the water was soft, you might afford to pipe that into the town and use it as drinking water, but if you must purify part of the water and build a dual system, the speaker is of the opinion that the flag that Mr. Diven held up will signal you to stop, because the cost will be prohibitive. Besides that, you will have to place dual faucets, which will be used accidentally, the one for the other, and there will be more sickness and more trouble from using the wrong faucets than would be occasioned by the use of raw water. They are filtering 100,000,000 gallons at Pittsburgh, and are not complaining about it. Very little of that water is used for any purpose for which it is not better filtered than it would be otherwise. On the Mississippi River, the turbidities run from 1000 to 10,000 p.p.m., what practical use can be made of that water without first clarifying and in clarifying, it must in a large degree be purified.

Mr. J. M. Diven: There is one point with reference to filtration that Mr. Chester did not touch upon. The small unit might do just as good work as the other, but it would be at considerably greater cost; in other words, your overhead charges, such as chemist, attendants, fuel, etc., would be as great for the small as for the large plant. In one instance within the experience of the speaker there was a perfectly pure water supply for domestic use. It was a delightful water for bathing and drinking purposes, but unsuited for mechanical purposes. The attempt was made to get customers enough to pay for piping this water around the city. The wells were right in the heart of the city, and had sufficient pressure for domestic purposes without pumping. The idea was to supply this water under a dual system for drinking purposes; but the effort to obtain sufficient customers to support the project was unsuccessful.

Mr. H. C. Hodgkins: The question of cost is largely guess work, and the speaker will not attempt to say that he has worked it out in detail, but the fact remains that the dual supply in some of our large cities has been seriously considered and is particularly desirable. Take the worst instance that you can pick out, the city of Syracuse; you who have been there know how they boast of their water supply. It has a double conduit line from Skaneateles Lake which it will surely outgrow. The manufacturing industries of the city are increasing rapidly. There is a better water for a great many purposes in Syracuse than even the Skaneateles water. The speaker doubts that the cost is the bugaboo; in fact, believes that large industries would require water that can be obtained at less cost than additional water of the same kind. The fact remains that where filtration plants are in operation, the bottled water business is increasing at a tremendous rate. The speaker does not mean to condemn filtration; be believes it to be the thing, but the fact is that the dual business is going on. Take the Black River water supply; you have there a safe water to filter. The speaker does not mean to say that it is not being filtered well, but in competition the bottled water is thriving to a great extent, although no bottled water anywhere can surpass the splendid Adirondack water that is available for the entire Black River Valley. The question is, shall that eminently pure water, the best that nature provides, be withdrawn from the inhabitants of that rich valley in favor of a black water made white by bleaching, or shall they have pure water to drink? The speaker doubts very much whether it will cost more, but believes that when you come to work it out the balance will be on the other side of the ledger. However, there is no iron-clad rule that will apply. It cannot be decided offhand or there would not be any use for the gentlemen of the profession here represented. The speaker does not contend that it will work out in all cases; but there are places where it is worth consideration and where he believes it will work out very much to the interest of the inhabitants.

Mr. Francis Ward Langstroth: New York City has a dual system from 23d Street to the Battery for fire protection, the normal pressure for domestic service is 40 pounds, the pressure of the dual system is 125 pounds, as soon as an alarm of fire is given, this can be raised, if necessary, to 300 pounds, should there be a serious conflagration water can be taken from the river for the high pressure system.

Mr. D. D. Jackson: In connection with what Mr. Langstroth has said the speaker would state that the salt water is not used in the fire protection pipes, but that the Croton supply is the only one that is used for fire purposes. While the salt water is connected, unless in the case of some great catastrophe, the salt water will probably never be used for fire purposes, so there is no dual system in New York City.

Mr. P. A. Maignen: There has never been a paper so well presented before this Association as the one we have just heard. In investigating whether a thing ought to be done, the first question is, Is it wanted? The second: Can it be done? And the third: How much does it cost? If, as in the discussion we have just heard, the question of cost is brought up in the beginning, the proposition will never be satisfactorily settled. On the other side of the Delaware, in Camden, they have wells with good water but they cannot draw more than a certain quantity, and therefore if the industrial establishments require more water it must be found elsewhere. The question of a separate line of pipe to supply those industries and the fire hydrants in the industrial district has been raised and it was proposed that the Delaware River should be scrubbed or submitted to preliminary filtration. This would be a proper solution of the problem.

The question of a double supply of water is indeed a very interesting one. Have we not heard this evening that modern filter plants are so erratic that they must be subject to the supervision of expert chemists every ten minutes. A filter system that requires such supervision should not be allowed to exist. The solution cannot be found by simply examining the sample every ten minutes or every hour, it can only be found in a double system of supply where the best water can be treated with care and the industrial water treated industrially. With one single supply the volume of water is too large to be handled in a satisfactory manner. The speaker has advocated dual canalization for years in the different engineering societies to which he belongs, and in this Association. The city of Paris has a double supply, one of spring water and one of filtered water (which is called "assimilated"). It has been said this evening that large filter plants are better than small ones because more expert supervision can be employed. In the experience of the speaker and that of others, it has been found that small filter units are more safe and more easily handled than big ones and do *not require* constant supervision. The big units may be all right when the water is at its best, but they are all wrong when it is at its worst.

It would seem then as if we are all agreed on the necessity for chemical purification. The question then is to have the engineers and experts find out the best chemical or chemicals to be used for the purification of water, but as this cannot be done everywhere at once it is suggested that in the same way as during times of epidemic, the boards of health and commissioners advise the people to boil their water, they should advise their clients in times of danger to sterilize the water themselves, in their own homes.

MR. FRANK C. KIMBALL: There is one point in regard to a duplicate or dual system which may be deemed a detail, but if so, it is a detail that should require very careful consideration in any city where such a system might be in operation. Without taking any exceptions whatever to anything that has been said as to the necessity for a dual system, the question would at once arise as to its practicability. The speaker believes that there are a number here who can recall the case at Lawrence, Massachusetts, where in the mills there was a dual system. The city water supply was filtered and there was no objection to it from any point of view for use for drinking purposes or for any other purpose that was necessary. The river water was polluted, but was piped through the mills for ordinary use in washing and for other things. The pipes conveying this polluted supply were very plainly marked, even to the extent of being of different color and style, and were labelled. A penalty was imposed on any employee or operative who used the river water. Notwithstanding this, after some little time this system had to be done away with because the operatives would not, nor could they be made to, keep away from the river water faucets when these happened to be just a little more convenient. This resulted in a great deal of sickness and disease, and in several cases, deaths were traced directly to it. It may be that some arrangement can be made which would make such dual use practicable; but we have this experience on record, which shows what one great difficulty is where two supplies enter the premises both to a very great extent having the same degree of availability, particularly if the use of one is going to cost more than the use of the other. At the present day it is safe to say that the large majority of the people are not educated to understand the difference as between water that cost 10 cents and water that cost, 30 cents to 40 cents. Both look alike to them, and, so far as they are concerned, taste alike, and we cannot at the present time make them see why they should use one rather than the other.

Mr. F. W. Cappelen: It would seem to the speaker that the greatest objection to a dual system, such as Mr. Kimball has referred to, is that it is the duty of every municipality today to furnish an absolutely pure supply of water for the inhabitants. It must be safe, so that a child can drink it, so that anyone can open a faucet anywhere and be safe, no matter whether it is an ignorant laborer or anybody else. It is not sufficient to care for the intelligent people who can afford to have fancy plumbing and fancy indicators, showing them from what pipes to draw the water, but it is the duty of the municipality to protect every inhabitant alike, and see that they are safe whenever they use drinking water. We cannot do that with a dual system, it is absolutely impossible.

Mr. P. A. Maignen: It is hard to understand why two spigots are needed in a yard. Why should there be one spigot for good water and another spigot for bad water? Why can they not use all good water when they consume so little of it? If a large quantity of water is needed in a yard for industrial purposes they could easily have a special hydrant which would not be convenient for drinking.

Mr. H. C. Hodgkins: Some years ago the speaker presented a paper to this Association, in which he promised to give, later on, a sequel. Those of you who retain your copies of *Proceedings* and who find them valuable, if you will look back will find the history of the water works at Newark, Ohio, and you will find it interesting to give it a re-reading, particularly those of you who may still be operating under franchises. The sequel in that case is that the city built a complete plant covering about 40 miles of street distribution. The original plant, which was constructed under specifications prepared by an eminent engineer and supervised by the city, covered about 30 miles of streets; so that in that case you have a thriving city of about 25,000 or 30,000 population, which has two systems of distribution covering at least 75 per cent of all the streets. Now, being the owner of a dual system, would it not be the part of wisdom to supply pure spring water through one system and the generally clear river water through the other system?